

Global Warming & Water

An Annotated Bibliography



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Water Resources

Arnell, Nigel. "Global Warming, River Flows and Water Resources." Chichester: John Wiley & Sons, 1996.

Description: This book reviews the potential effects of global warming on river flows and water resources. It covers methodologies for climate change impact assessments, techniques for defining credible climate change scenarios, and models for hydrological analysis.

Summary: <http://www.wiley.com/WileyCDA/WileyTitle/productCd-0471965995.html>

Barnett et al. "Human-Induced Changes in the Hydrology of the Western United States." *Science* Volume 319 (2008): 1080-1083.

Abstract: <http://www.sciencemag.org/cgi/content/abstract/319/5866/1080>

Description: The authors demonstrate that up to 60% of the hydrological changes (river flow, winter air temperature, snow pack) in the Western United States over the last half of the 20th century are due to human-caused climate changes from greenhouse gases and aerosols. The authors predict water shortages, lack of storage capacity to meet seasonally changing river flows and other impacts in the future.

Barnett, T.P, J.C. Adam and D.P. Lettenmaier. "Potential Impacts of a Warming Climate on Water Availability in Snow-Dominated Regions." *Nature* 438.7066 (2005): 303-309.

Available: [http://itpcas.ac.cn/system/uploadfiles/Barnett%2005-nature04141-](http://itpcas.ac.cn/system/uploadfiles/Barnett%2005-nature04141-Potential%20impacts%20of%20a%20warming%20climate%20on%20water%20availability%20in%20snow-dominated%20regions.pdf)

[Potential%20impacts%20of%20a%20warming%20climate%20on%20water%20availability%20in%20snow-dominated%20regions.pdf](http://itpcas.ac.cn/system/uploadfiles/Barnett%2005-nature04141-Potential%20impacts%20of%20a%20warming%20climate%20on%20water%20availability%20in%20snow-dominated%20regions.pdf)

Description: The decrease in snowfall and changes in melting patterns will have serious implications for freshwater resources. If the Earth warms 1-2 degrees Celsius in the next decades, snow will melt earlier in the spring, creating higher peak flows and decreasing water availability later in the summer when it is most needed. Reservoirs are generally already full in the spring so the additional peak flows from snow melt will not be captured. More than a billion people currently live in areas that will be affected.

Bates et al. "Technical Paper on Climate Change and Water." Geneva: Intergovernmental Panel on Climate Change, 2008.

Available: <http://www.ipcc.ch/meetings/session28/doc13.pdf>

Description: A comprehensive examination of the global impacts of climate change on water resources.

Cohen, Stewart et al. "North America." *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. IPCC. Cambridge: Cambridge University Press, 2001.

Available: http://www.grida.no/climate/ipcc_tar/wg2/pdf/wg2TARchap15.pdf

Description: Discusses water resources impacts for North America beginning on page 745 (page 11 of the pdf). There is much uncertainty about changes in precipitation but agreement that basins relying heavily on snowmelt will experience higher winter runoff and possible reductions in summer flows. Possible increases in precipitation events may result in greater damages from flooding, landslides, sewer overflows and water pollution.

Dracup, J. A., S. Vicuna, R. Leonardson, L. Dale, M. Hanneman. "Climate Change and Water Supply Reliability." California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2005-053, 2005.

Available:

<http://calclimate.berkeley.edu/3%20Climate%20Change%20and%20Water%20Supply%20Reliability.pdf>

Description: This study assesses the economic costs associated with potential changes in the reliability of water supply due to climate change for users in various parts of the state. The authors find that water supply reliability varies widely for different users within the Central Valley. While annual water supply reliability may be high, there are supply deficits in certain months, especially during the growing season.

Field, C.B. et al. "North America." *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry et al. Eds., Cambridge: Cambridge University Press, 2007. 617-652.

Available: <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter14.pdf>

Description: Discusses the vulnerabilities of freshwater resources in North America to climate change. Basins relying heavily on snowmelt will experience higher winter runoff and possible reductions in summer flows. Possible increases in precipitation events may result in greater damages from flooding and water pollution.

Fischlin, A. et al. "Ecosystems, their Properties, Goods, and Services." *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth*

Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, et al., Eds., Cambridge: Cambridge University Press, 2007. 211-272.

Available: <http://www.gtp89.dial.pipex.com/04.pdf>

Description: Contains description of effects on lakes, streams and wetlands beginning on page 233. The authors predict the loss of habitat for coldwater fish, increases in extinctions and invasions of exotics and potential increase in pollution problems.

Gleick et al. "Water: Potential Consequences of Climate Variability and Change for the Water Resources of the United States." *National Assessment of the Potential Consequences of Climate Variability and Change*. Washington, DC: US Global Change Research Program, 2000.

Available: <http://www.gcrio.org/NationalAssessment/water/water.pdf>

Description: Comprehensive report on the impacts of climate change on US water resources and managed water systems.

By: Groves, David G., Debra Knopman, Robert J. Lempert, Sandra H. Berry, Lynne Wainfan. "Identifying and Reducing Climate-Change Vulnerabilities in Water-Management Plans", Rand Corporation, 2008.

Available: http://www.rand.org/pubs/research_briefs/RB9315/

This research brief summarizes work with Southern California's Inland Empire Utilities Agency to help it identify climate-change vulnerabilities in its long-term water plans and evaluate its most effective options for managing those risks.

Hurd, Brian et al. "Climactic Change and U.S. Water Resources: From Modeled Watershed Impacts to National Estimates." *Journal of the American Water Resources Association* Vol. 40.1 (2004): 129-148.

Available: <http://agecon.nmsu.edu/bhurd/hurdhome/Hurd%20Pubs/Hurd-JAWRA-climatewater.pdf>

Description: The authors use models to predict changes in water availability in four watersheds and assess the resulting economic impacts. They extend these lessons to provide a national assessment of economic impacts from changes in water resources due to climate change.

Jacobs, Katherine, D. Briane Adams and Peter Gleick. "Potential Consequences of Climate Variability and Change for the Water Resources of the United States." *Climate Change Impacts on the United States*. Washington, DC: US Global Change Research Program, 2001.

Available: <http://www.usgcrp.gov/usgcrp/Library/nationalassessment/14Water.pdf>

Description: The authors predict changes in rainfall patterns and increased water demand due to higher temperatures. They foresee the potential to for the water management system to adapt to these changes. They also note that there will be a decrease in soil moisture across the Midwest, increased water pollution due to high-intensity storm events and surprises that we cannot presently predict.

Kabat, Pavel and Henk van Schaik. "Chapter 2: Impacts" *Climate Changes the Water Rules: How Water Managers Can Cope with Today's Climate Variability and Tomorrow's Climate Change*. Delft: Dialogue on Water and Climate, 2003.

Available: <http://www.waterandclimate.org/UserFiles/File/changes.pdf>

Description: Discusses future water availability, impacts on health and food supply among other topics. Includes a number of useful maps.

Kundzewicz, Z.W et al. “Freshwater Resources and Their Management.” *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry et al. Eds., Cambridge: Cambridge University Press, 2007. 173-210.

Available: <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter3.pdf>

Description: IPCC’s report on water resources. It includes discussions of impacts on precipitation, river flows, water quality, water use, and management options.

Lettenmaier, D.P., A.W. Wood, R.N. Palmer, E.F. Wood and E.Z. Stakhiv. “Water Resources Implications of Global Warming: A U.S. Regional Perspective,” *Climatic Change*. 43 (1999): 537–579.

Abstract: <http://www.springerlink.com/content/x6817wgg0088854x/>

Description: The authors examined the hydrologic implications of global warming for four U.S. water resource systems. Those that depend on snow exhibit a large change in seasonal streamflow.

Miller, Kathleen and David Yates. “Climate Change and Water Resources: A Primer for Municipal Water Providers.” Denver: American Water Works Association Research Foundation, 2005.

Available: <http://www.awwarf.org/research/TopicsAndProjects/execSum/2973.aspx>

Description: This report examines the impacts of global warming on municipal water supply and suggests adaptive strategies to reduce the consequences. They advocate using top down climate models to measure future impacts and bottom up assessments of a utility’s vulnerability.

Milly, P.C.D, K.A. Dunne and A.V. Vecchia. “Global pattern of trends in streamflow and water availability in a changing climate.” *Nature* 438.7066 (2005): 347-351.

Available: <http://www.gfdl.noaa.gov/reference/bibliography/2005/pcm0502.pdf>.

Description: The authors use a number of different climate models to predict changes in runoff around the globe. They estimate that by 2050 the western U.S., southern Africa, and areas surrounding the Mediterranean Sea will receive 10-30% less runoff than they currently do.

Milly, P.C.D et al. “Stationarity is Dead: Whither Water Management?” *Science* 319 (2008): 573-573.

Available: http://www.gfdl.noaa.gov/bibliography/related_files/pcm0801.pdf

Description: The authors argue that the principle of stationarity – the idea that natural systems fluctuate within an unchanging range of variability – used to make water management decisions no longer applies because of human disturbances. They advocate for updating models to reflect changing conditions in order to make more accurate water management decisions.

Moore, Marianne et al. “Potential Effects of Climate Change on Freshwater Ecosystems of the New England/Mid-Atlantic Region.” *Hydrological Processes* Vol. 11 (1997): 925-947.

Available: http://www.srs.fs.usda.gov/pubs/ja/ja_moore001.pdf

Description: The authors predict significant changes to freshwater ecosystems in the region. Increased evaporation could cause a 21-31% reduction in annual stream flow in parts of the region. Includes recommendations for future research.

Mortsch, Linda, Marianne Alden and Joel Scheraga. "Climate Change and Water Quality in the Great Lakes Region: Risks, Opportunities, and Responses." Prepared for the Great Lakes Water Quality Board of the International Joint Commission. August, 2003.

Available: http://www.ijc.org/rel/pdf/climate_change_2003_part3.pdf

Description: A white paper commissioned by the Great Lakes Water Quality Board to explore the implications of a changing climate on the Great Lakes watershed. The study focuses on four questions: What are the Great Lakes water quality issues associated with climate change? What are the potential impacts of climate change on the beneficial uses in the Great Lakes Water Quality Agreement? How might these impacts vary across the Great Lakes? What are the implications for decision-making?

Mote, Philip W. et al. "Preparing for Climatic Change: The Water, Salmon, and Forests of the Pacific Northwest." *Climactic Change*, 61.1-2 (2004): 45-88.

Abstract: <http://www.springerlink.com/content/t201899171134th3/>

Description: The authors analyze the impacts of climactic shifts in the Pacific Northwest, finding a decrease in regional snowpack, which supplies freshwater in summer. They find that regional water planners have few plans for adapting to climactic shifts.

Mulholland, Patrick et al. "Effects of Climate Change on Freshwater Ecosystems of the South-Eastern United States and the Gulf Coast of Mexico." *Hydrological Processes* Vol. 11.8 (1997): 949-970.

Abstract: <http://www3.interscience.wiley.com/cgi-bin/abstract/11446/ABSTRACT>

Description: The authors predict increased precipitation and evapotranspiration in the region, resulting in an overall decrease in runoff. Among other impacts they predict a decrease in habitat for cool-water species, a northward shift of subtropical species, drying of wetlands in some areas and an increase in eutrophication in Florida lakes.

Najjar, Raymond et al. "The Potential Impacts of Climate Change on the Mid-Atlantic Coastal Region." *Climate Research* Vol. 14 (2000): 219-233.

Available: http://www.cara.psu.edu:8001/about/publications/Najjar_et_al_2000.pdf

Description: The authors assess potential impacts on the Mid-Atlantic coastal region. Most of the changes are expected to be negative. Sea level rise threaten coastal wetlands and increased streamflow could degrade water quality.

National Wildlife Federation. "More Variable and Uncertain Water Supply: Global Warming's Wake-Up Call for the Southeastern United States." Washington: National Wildlife Federation, 2008.

Available:

<http://www.nwf.org/news/clickThru.cfm?path=/nwfwebadmin/binaryVault/NWF%5FSEWaterSupply%5FFINAL2%2Epdf>

Description: A short report on water supply in the Southeast with a good selection of statistics from other reports. The report argues that the combination of increase demand due to expanding

populations and irrigation combined with less predictable precipitation have made the Southeast highly vulnerable to drought. The economy and natural resources are at risk as a result.

Neff, Rob et al. "Impact of Climate Variation and Change on Mid-Atlantic Region Hydrology and Water Resources." *Climate Research* Vol. 14 (2000): 207-218.

Available: <http://www.int-res.com/articles/cr/14/c014p207.pdf>

Description: The authors use climate models to assess potential changes in streamflow and groundwater recharge in the Mid-Atlantic Region. The two models predict different responses to climate change, although both predict increased nutrient loading in the winter and spring.

Nijessen, Bart, Greg O'Donnell, Alan Hamlet and Dennis Lettenmaier. "Hydrologic Sensitivity of Global Rivers to Climate Change." *Earth and Environmental Science* 50.1-2 (2001): 143-175.

Abstract: <http://www.springerlink.com/content/m24116121218031x/>

Description: The authors analyze changes to the hydrological cycle in 9 major river basins under several climate prediction models. The largest changes are predicted for snow-dominated basins in mid to higher latitudes.

Nordstrom, Kirk. "Effects of Seasonal and Climatic Change on Water Quality from Acid Rock Drainage in the Western United States." In: Cidu, R. and Frau F. (eds.) Proceedings of the IMWA Symposium, 2007, *Water in Mining Environments*. Cagliari, May 27-31 2007.

Available: http://www.imwa.info/docs/imwa_2007/IMWA2007_Nordstrom.pdf

Description: The author examines the impacts of climate change on acid mine drainage in the U.S. He finds that concentrations of metals and acid increase dramatically after large rain events following extended droughts. Concentrations increase gradually over long low-flow periods. This will result in worse water quality under warming conditions and more expensive remediation efforts.

Palmer, Margaret et al. "Climate Change and the World's River Basins: Anticipating Management Options." *Frontiers in Ecology and the Environment* (2007).

Abstract: <http://www.esajournals.org/doi/abs/10.1890/060148>

Description: The authors project river discharge under different climate and water withdrawal scenarios and combine this with data on the impact of dams on large river basins to create global maps illustrating potential changes in discharge and water stress for dam-impacted and free-flowing basins. The projections indicate that every populated basin in the world will experience changes in river discharge and many will experience water stress. The magnitude of these impacts is used to identify basins likely and almost certain to require proactive or reactive management intervention. Our analysis indicates that the area in need of management action to mitigate the impacts of climate change is much greater for basins impacted by dams than for basins with free-flowing rivers. Nearly one billion people live in areas likely to require action and approximately 365 million people live in basins almost certain to require action. Proactive management efforts will minimize risks to ecosystems and people and may be less costly than reactive efforts taken only once problems have arisen.

Poff, N. Leroy, Mark Brinson, and John Day. "Aquatic Ecosystems & Global Climate Change: Potential Impacts on Inland Freshwater and Coastal Wetland Ecosystems in the United States." Arlington: The Pew Center on Global Climate Change, 2002.

Available: <http://www.pewclimate.org/docUploads/aquatic.pdf>

Rogers, Catriona and John McCarty. "Climate Change and Ecosystems of the Mid-Atlantic Region." *Climate Research* Vol. 14 (2000): 235-244.

Available: <http://www.int-res.com/articles/cr/14/c014p235.pdf>

Description: Discusses the current state of forested, wetland, freshwater and coastal ecosystems in the Mid-Atlantic region and how climate change could interact with existing stresses. Urban development and wetland loss may leave rivers and streams vulnerable to damage from increased precipitation.

Rood, Stewart et al. "Twentieth-Century Decline in Streamflows from the Hydrographic Apex of North America." *Journal of Hydrology* Vol. 306 (2005): 215-233.

Available: http://www.rmrs.nau.edu/awa/riphreatbib/Rood_etal_2005.pdf

Description: The authors examine annual discharge rates for 31 river reaches in the Rocky Mountain region over the course of the 20th century. 21 of the 31 reaches displayed significant declines in discharge. Overall the average decline was .22% per year. The authors predict continued declines in future decades with impacts on ecosystem health and human uses.

Stewart, Iris, Daniel Cayan and Michael Dettinger. "Changes toward Earlier Streamflow Timing across Western North America." *Journal of Climate* Vol. 18 (2005): 1136-1155.

Available: http://tenaya.ucsd.edu/~dettinge/stewart_timing.pdf

Description: The authors find that annual flow in river basins in the western U.S. is occurring earlier in the water year by 1-4 weeks. The change is caused by higher winter and spring temperatures. Continued rises in average temperatures due to climate change could have significant negative effects.

Stewart, I., D.R. Cayan, and M.D. Dettinger. "Changes in snowmelt runoff timing Changes in snowmelt runoff timing in western North America under a 'Business as Usual,'" *Climatic Change* 62 (2004): 217-232.

Available: http://meteora.ucsd.edu/cap/stewart_clch.pdf

Description: Authors model changes in the timing of springtime snowmelt and streamflow timing based on climate models. They find that snowmelt runoff in many western rivers will occur 20-40 days earlier by the end of the century relative to 1951-1980 conditions. Changes will be most pronounced in the Pacific Northwest, Sierra Nevada and Rocky Mountain regions.

Tague, Christina et al. "Deep Groundwater Mediates Streamflow Response to Climate Warming in the Oregon Cascades." *Climatic Change* 86.1-2 (2008): 1573-1480.

Available: http://www.fsl.orst.edu/wpg/pubs/08_Tagueetal_Climate.pdf

Description: The authors model summer instream flow of waterways in two snowpack-dominated basins, one with significant groundwater input and one without. They find that streams with significant groundwater inputs will maintain significant instream flow under warming conditions. Streams without groundwater inputs will become more intermittent, but most of them already have very low flows during summer months. These streams will experience a longer low-flow period most years, but groundwater-fed basins will lose more summer flow in absolute terms.

Thompson et al. “Climate Change Impacts for the Coterminous USA: An Integrated Assessment,” *Climactic Change* 69.1 (2005): 67-88.

Abstract: <http://www.springerlink.com/content/h2506v871056530x/>

Description: The authors use projections of future precipitation patterns in the US to anticipate the sufficiency of future water supply to meet the changing demands of irrigated agriculture.

U.S. Climate Change Science Program. “The Global Water Cycle” *Our Changing Planet: The U.S. Climate Change Science Program for Fiscal Year 2007* Washington, DC, 2006.

Available: <http://www.usgcrp.gov/usgcrp/Library/ocp2007/ocp2007-hi-water.pdf>

Description: Includes a description of recent climate change research carried out by the group.

U.S. Environmental Protection Agency. “Climate Change Effects on Stream and River Biological Indicators: A Preliminary Analysis.” Global Change Research Program, National Center for Environmental Assessment, Washington, DC; EPA/600/R-07/085.

Available: http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=472966

Description: The report discusses potential impacts of climate change on biological indicators in streams and rivers and outlines strategies for monitoring the impacts in the future.

U.S. Environmental Protection Agency. “A Screening Assessment of the Potential Impacts of Climate Change on Combined Sewer Overflow (CSO) Mitigation in the Great Lakes and New England Regions.” Washington: EPA, 2006.

Description: This study examines the extent to which CSO long-term control plans may be underdesigned if planners do not take into account the effects of climate change. The study finds that due to the expected increase in extreme storm events, many communities in the Great Lakes Region will not be able to meet the goal found in Long Term Control Plans of reducing CSOs to fewer than four a year if their abatement measures are based on historical precipitation characteristics.

U.S. Global Change Research Program. “Global Climate Change Impacts in the United States”, Thomas R. Karl, Jerry Melillo, and Thomas Peterson (eds.). Cambridge University Press, 2009.

Available: <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts>

Description: This comprehensive report summarizes the impacts of climate change on the U.S. and includes a section on water resources. It collects the latest and best science specifically focusing on climate change in the U.S.

Wilbanks, T.J. et al. “Industry, Settlement and Society.” *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry et al. Eds., Cambridge: Cambridge University Press, 2007. 357-390.

Available: <http://www.gtp89.dial.pipex.com/07.pdf>

Description: Includes a short section on the impacts of climate change on water supply and sanitation beginning on page 370. The authors note that climate change could increase water demand, decrease supply and damage water infrastructure.

Vörösmarty, Charles J., Pamela Green, Joseph Salisbury, and Richard B. Lammers. "Global Water Resources: Vulnerability from Climate Change and Population Growth," *Science* Vol. 289 (2000): 284-288.

Abstract: <http://www.sciencemag.org/cgi/content/abstract/289/5477/284>

Description: The authors forecast future water supply and demand, concluding that growing water demand will greatly outweigh global warming in defining the state of global water systems by 2025.

Yarnal, Brent. "Integrated Regional Assessment and Climate Change Impacts in River Basins." *Climate Research* Vol. 11 (1998): 65-74.

Available: <http://www.int-res.com/articles/cr/11/c011p065.pdf>

Description: Discusses integrated regional assessments as a tool for measuring and planning for potential impacts of climate change. Includes assessments of the Susquehanna River Basin and two others.

Groundwater

Chen, Chi-Chung, Dhazn Gillig, and Bruce A. McCarl. "Effects of Climatic Change on a Water Dependent Regional Economy: A Study of the Texas Edwards Aquifer," *Climatic Change* Vol. 49.4 (2001): 397-409.

Available: <http://agecon2.tamu.edu/people/faculty/mccarl-bruce/papers/781.pdf>

Description: This study presents an analysis of changes in water supply and demand in areas dependent on the Edwards Aquifer. It also looks at economic impacts of climate change in the area. They predict a decrease in water supply, increase in demand and an economic decline.

Hiscock, Kevin and Yu Tanaka. "Potential Impacts of Climate Change on Groundwater Resources: From the Highlands of the U.S. to the Flatlands of the U.K." *National Hydrology Seminar*, 2006.

Available: <http://www.opw.ie/hydrology/data/speeches/Hiscock.pdf>

Description: The authors present an overview of climate change impacts on groundwater, focusing on groundwater recharge and saline intrusion. They find that the impacts will be highly variable based on geo-climatic zones and difficult to deal with.

Loáiciga, Hugo. "Climate Change and Ground Water." *Annals of the Association of American Geographers* 93.1 (2003): 30-41.

Description: This study focuses on modeling of aquifer response to climate change. The author stresses the importance of accounting for climate change when managing groundwater resources but note that changes in aquifer use may have a greater impact than climate change.

Available: <http://www.blackwell-synergy.com/doi/pdf/10.1111/1467-8306.93103?cookieSet=1>

Northeast Climate Impacts Assessment (NECIA). "Climate Change in the U.S. Northeast." Cambridge: UCS Publications, 2006.

Available:

http://www.climatechoices.org/assets/documents/climatechoices/NECIA_climate_report_final.pdf

Description: This study analyzes the impacts of climate change on the northeast U.S. and its water resources under business-as-usual and lower-emissions scenarios. The impacts under the second scenario are considerably less severe, including a smaller decrease in winter snow fall, fewer droughts and reduced sea-level rises.

Ranjan, Priyantha, So Kazama and Masaki Sawamoto. “Effects of Climate Change on Coastal Fresh Groundwater Resources.” *Global Environmental Change* Vol. 16 (2006): 388-399.

Available: <http://www.aseanenvironment.info/Abstract/41014118.pdf>

Description: This study evaluates the impacts of climate change on fresh groundwater resources specifically salinity intrusion in water-stressed coastal aquifers. The authors predict increasing loss of groundwater resources and discuss associated socio-economic impacts.

Rosenberg, Norman J., Daniel J. Epstein, David Wang, et al. “Possible Impacts of Global Warming on the Hydrology of the Ogallala Aquifer Region.” *Climatic Change* Vol. 42.4 (1999): 677-692.

Abstract: <http://www.globalchange.umd.edu/publications/51/>

Description: This article assesses the possible impacts of climate change on the sustainability of the Ogallala Aquifer as a source of water for irrigation and other purposes in the region. The authors predict decreased precipitation and decreased yield from the aquifer, which provides water for about 20% of the irrigated land in the U.S.

Health

Balbus, John and Mark Wilson. “Human Health and Global Climate Change: A review of Potential Impacts in the United States.” Arlington: Pew Center on Global Climate Change, 2000.

Available: http://www.pewclimate.org/global-warming-in-depth/all_reports/human_health/index.cfm

Description: The authors assess existing evidence of climate-related health risks and predict increased health threats due to heat waves and increased air pollution. Increased risk of vector- and water-borne diseases can be decreased with adequate investment in sanitation and public health system infrastructure.

Bernard, Susan et al. “The Potential Impacts of Climate Variability and Change on Air Pollution-Related Health Effects in the United States.” *Environmental Health Perspectives* Vol. 109.S2 (2001): 199-209.

Available: <http://www.ehponline.org/docs/2001/suppl-2/199-209bernard/bernard.pdf>

Description: The authors review health effects associated with air pollution and the changes global warming may bring. They note that while air pollution will be affected by climate change, it is difficult to predict how. They also detail future research needs.

Climate Change Science Program (CCSP). “Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems.” A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks (authors). Washington, DC: U.S. Environmental Protection Agency, 2008.

Available: <http://www.climatechange.gov/Library/sap/sap4-6/final-report/>

Description: The report finds that human health will be negatively impacted by climate change due to the greater frequency of heat waves and floods. Human settlements will also incur costs, especially because of greater uncertainty in water supply. The authors stress that climate-related impacts will interact with other demographic, land use and economic shifts to determine overall well-being. They note that improvements to the public health system and infrastructure investment (including treatment plants and flood control structures) will improve our ability to adapt.

Githeko et al. “Climate Change and Vector-borne Diseases: A Regional Analysis.” *Bulletin of the World Health Organization* Vol. 78.9 (2000): 1136-1147.

Available: [http://whqlibdoc.who.int/bulletin/2000/Number%209/78\(9\)1136-1147.pdf](http://whqlibdoc.who.int/bulletin/2000/Number%209/78(9)1136-1147.pdf)

Description: The authors discuss how the presence of vector-borne diseases will change with climate change, identifying which regions will have the largest changes. They also discuss how human settlement patterns (urban vs. rural) will impact these changes.

Greenough, Gregg et al. “The Potential Impacts of Climate Variability and Change on Health Impacts of Extreme Weather Events in the United States.” *Environmental Health Perspectives* Vol. 109.S2 (2001): 191-198.

Available: <http://www.ehponline.org/docs/2001/suppl-2/191-198greenough/greenough.pdf>

Description: The authors note that models predict an increase in extreme precipitation events but stress that the frequency of hurricanes and tornadoes cannot be predicted. The health impacts are dependent on the vulnerabilities and recovery capabilities of the population.

Gubler et al. “Climate Variability and Change in the United States: Potential Impacts on Vector- and Rodent-Borne Diseases.” *Environmental Health Perspectives* Vol. 109.S2 (2001): 223-233.

Available: <http://www.ehponline.org/docs/2001/suppl-2/223-233gubler/gubler.pdf>

Description: This report discusses the sensitivity of vector-borne diseases to rainfall, temperature and weather and the implications for human health in the U.S. Global warming may increase the probability of transmission for some diseases and decrease it for others. The US will not experience major outbreaks if it maintains its public health infrastructure.

McGeehin, Michael and Maria Mirabelli. “The Potential Impacts of Climate Variability and Change on Temperature-Related Morbidity and Mortality in the United States.” *Environmental Health Perspectives* Vol. 109.S2 (2001): 185-189.

Available: <http://www.ehponline.org/docs/2001/suppl-2/185-189mcgeehin/mcgeehin.pdf>

Description: The report predicts increases in heat-related illness and death, especially in the Northeast and Midwest and among vulnerable populations. The authors discuss adaptation methods that can reduce the impacts.

McMichael et al (eds.). “Climate Change and Human Health: Risks and Responses.” Geneva: WHO, 2003.

Available: <http://www.who.int/globalchange/publications/cchhbook/en/index.html>

Description: A comprehensive report (300+ pages) on the human health risks associated with global warming.

Patz et al. "Potential Consequences of Climate Variability and Change for Human Health in the United States." *Climate Change Impacts on the United States*. Washington, DC: US Global Change Research Program, 2001.

Available: <http://www.usgcrp.gov/usgcrp/Library/nationalassessment/15Health.pdf>

Description: This study focuses on temperature-related illness and death, extreme weather events, air pollution, water- and food- borne diseases and insect-, tick- and rodent- borne diseases.

Rose, Joan et al. "Climate Variability and Change in the United States: Potential Impacts on Water- and Foodborne Disease Caused by Microbiologic Agents." *Environmental Health Perspectives* Vol. 109.S2 (2001): 211-220.

Available: <http://www.ehponline.org/docs/2001/suppl-2/211-221rose/rose.pdf>

Description: The report discusses the link between climate change and microbial disease, focusing on the need for further research.

Extreme Weather Events

Association of British Insurers. "Financial Risks of Climate Change." London: Association of British Insurers, 2005.

Available:

http://www.abi.org.uk/Display/File/Child/552/Financial_Risks_of_Climate_Change.pdf

Description: This report examines the financial implications of climate change through its effects on extreme storms on the insurance industry. Overall, they find that climate change could significantly increase the costs of storm damage. The increased wind-related insured losses from US hurricanes could increase by around 75% to total \$100-150 billion. This does not include damages from hurricane-related flooding. The authors argue that insurance can be a messenger of the costs of climate change, but also that climate change could increase the volatility of insurance markets if the impacts are not anticipated.

Climate Change Science Program (CCSP). "Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands." A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Thomas R. Karl et al., eds. Department of Commerce, NOAA's National Climatic Data Center, Washington, DC, 2008.

Available: <http://www.climatechange.gov/Library/sap/sap3-3/final-report/default.htm>

Description: This comprehensive report outlines the changes in flood, drought, heat wave and hurricane frequency and intensity in past decades. The authors predict further increases in floods and droughts for many parts of North America in the future. The report details the consequences of increases in extreme weather and examines the degree to which these increases can currently be connected to human-induced climate change.

Easterling, David et al. "Climate Extremes: Observations, Modeling, and Impacts." *Science* 289 (2000): 2068-2074.

Available: http://www.biosci.utexas.edu/ib/faculty/parmesan/classes/Eastl_Ntr_00.pdf

Description: The authors summarize past work examining observed changes in extreme precipitation events and models of future changes. They also review the potential impacts on US

society and natural systems. They find trends towards heavier rain storms and higher temperatures.

Maplecroft. “USA and China Top Global Risk Ranking for Economic Loss Due to Natural Disasters Linked to Climate Change.” Bath, UK, 2009.

Available: http://maplecroft.com/Maplecroft_Natural_Disasters_2009.pdf

Description: In 2008, the U.S. and China suffered 90% of the economic losses from climate change. This document introduces a series of climate risk maps that assess the risk from natural disasters related climate change.

Mills, Evan. “From Risk to Opportunity: 2007. Insurer Responses to Climate Change.” Boston: Ceres, 2007.

Available: <http://www.ceres.org/pub/docs/Risk-to-Opportunity-2007.pdf>

Description: This report argues that the insurance industry can develop creative loss-prevention solutions and products that will reduce climate-related losses for consumers, governments and insurers. The report examines 422 products and services offered by insurers around the world that will help reduce emissions and reduce vulnerability to climate change. Examples include pay-as-you-drive insurance policies and products that encourage hurricane-resistant construction. The introduction includes a review of the literature on the projected increase in insured losses due to more frequent and severe storms.

Vellinga, P. and W. J. van Verseveld. “Climate Change and Extreme Weather Events.” Gland, Switzerland: World Wide Fund for Nature (WWF), 2000.

Available: http://panda.org/downloads/climate_change/xweather.pdf.

Description: A review of the literature on climate change and extreme weather events. The authors conclude that mankind has had an effect on the frequency and intensity of these events.

Drought

Burke, Eleanor. “Effects of Climate Change in Developing Countries.” Exeter: Met Office Hadley Center for Climate Change, 2006.

Available: <http://www.metoffice.gov.uk/research/hadleycentre/pubs/brochures/COP12.pdf>

Description: The study assesses the risk of drought over the coming century, predicting that one third of the planet will be desert by 2100.

Seager, Richard et al. “Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America.” *Science* Vol. 316 (1181-1184): 2007.

Available:

<http://www.sciencemag.org/cgi/rapidpdf/316/5828/1181.pdf?ijkey=CAIzmuA008O0.&keytype=ref&siteid=sci>

Description: The authors examine a number of climate models and find a broad consensus that the American Southwest is transitioning to a significantly more arid climate. They predict that the levels of aridity of the Dust Bowl or 1950s droughts will become standard within years to decades.

Flood

Allianz Group and WWF. “Climate Change and Insurance: An Agenda for Action in the United States.” October, 2006.

Available: http://assets.panda.org/downloads/allianz_wwf_climate_change_and_insurance_embargoed_oct_2006.pdf

Description: The study examines the implications of floods, forest fires and hurricanes for the U.S. insurance industry. They find that the US insurance industry is more advanced in using historical data to predict catastrophic events but are behind Europeans in incorporating changes that will accompany climate change.

Baxter, PJ, I Moller, T Spencer, RJ Spence and S Tapsell. “Flooding and Climate Change.” *Health Effects of Climate Change in the UK*. London: Expert Group on Climate Change and Health in the UK, 2001.

Available: <http://www.dh.gov.uk/assetRoot/04/06/88/79/04068879.pdf>

Description: The authors predict increased flooding in low-lying coastal areas of the UK and call for increased research and review of emergency plans to counter this risk.

Few, Roger, Mike Ahern, Franziska Matthies and Sari Kovats. “Floods, Health and Climate Change: A Strategic Review.” Norwich: Tyndall Center, 2004.

Available: http://www.tyndall.ac.uk/publications/working_papers/wp63.pdf

Description: The authors present a comprehensive report on health risks from flooding and possible responses to decrease vulnerability. They go on to assess the implications of climate change and increased flood risk for human health. There is a shortage of data on the health outcomes of floods, but sufficient evidence to conclude that infectious disease is a major health concern in the global south.

Hoff et al. “Risk Management in Water and Climate – the Role of Insurance and Other Financial Services.” International Dialogue on Water and Climate, Delft: The Netherlands, 2003.

Available: <http://www.waterandclimate.org/news/Documents/DWC-FI-end2.pdf>

Description: The study discusses the increasing impacts and costs of water-related disasters and the role the insurance industry can play in reducing risk.

Hunt, JCR. “Floods in a Changing Climate: A Review.” *Philosophical Transaction of the Royal Society of London* Vol. 360 (2002): 1531-1543.

Available: <http://www.cpom.org/research/jcrh-rs.pdf>

Description: The author reviews predictions of increased risk due to flooding, unresolved scientific questions and strategies of adaptation.

Kefer et al. “America’s Flood Risk is Heating Up.” New York: Environmental Defense, 2007.

Available:

http://www.environmentaldefense.org/documents/6271_AmericasFloodRiskIsHeatingUp.pdf

Description: The authors present evidence that coastal and inland flooding are increasing as a result of global warming. They also discuss the shortcomings of current flood control programs and make recommendations for reform.

Madsen, Travis and Emily Figdor. “When It Rains, It Pours: Global Warming and the Rising Frequency of Extreme Precipitation in the United States.” Environment America Research & Policy Center, 2007.

Available: <http://environmentamerica.org/home/reports/report-archives/global-warming-solutions/global-warming-solutions/when-it-rains-it-pours>

Description: The authors examine rainfall data since 1948 and conclude that extreme precipitation events have increased in frequency by 24% across the Continental United States. New England and the Mid-Atlantic have experienced increases of 61% and 42%, respectively. The report also describes the science behind increasing extreme precipitation events and argues for greenhouse gas reductions to prevent further growth in severe storms.

Milly, P., R. Wetherald, K. Dunne and T. Delworth. “Increasing the Risk of Great Floods in a Changing Climate.” *Nature* Vol. 415.6871 (2002): 514-517.

Abstract: <http://cat.inist.fr/?aModele=afficheN&cpsidt=13513713>

Description: The authors find an increase in the frequency of great floods during the 20th century and predict the trend will continue in the future.

Palmer, T and J. Räisänen. “Quantifying the risk of extreme seasonal precipitation events in a changing climate.” *Nature* Vol. 415.6871 (2002): 512-514.

Abstract: <http://cat.inist.fr/?aModele=afficheN&cpsidt=13513712>

Description: The authors predict an increase in extreme rain events over the next 100 years with the possibility of increased flooding.

Schnur, Reiner. “Climate science: The investment forecast,” *Nature* Vol. 415.6871 (2002): 483 - 484.

Available: <http://www.not-clima.net/fr1.pdf>

Description: The article discusses the state of climate and flood models, emphasizing their shortcomings at present.

Wildlife

Allen, David and Alexander Flecker. “Biodiversity Conservation in Running Waters.” *Bioscience* 43 (1993): 32-43.

Available: http://www-personal.umich.edu/~dallan/pdfs/Allan_Flecker.pdf

Description: This article discusses the diversity of fish, vertebrate, invertebrate and plant species in river and stream systems across geographic regions. It also describes six threats to biodiversity in these systems including habitat loss and fragmentation, invasive species, overharvesting, secondary extinctions, chemical and organic pollution, and climate change. Habitat fragmentation in combination with rising water temperatures could lead to extinction of certain fish species.

Climate Change Connection. “Climate Change and Wildlife.”

Available: http://www.climatechangeconnection.org/pdfs_ccc/wildlife.pdf

Description: A well-documented summary of climate change impacts on wildlife. The evidence shows wide ranging impacts on many species.

Eaton, J.G. and R.M. Scheller. "Effects of Climate Warming on Fish Thermal Habitat in Streams of the United States." *Limnology and Oceanography* Vol. 41.5 (1996): 1109-1115.

Abstract: <http://cat.inist.fr/?aModele=afficheN&cpsidt=3253298>

Description: The authors find that habitat for cold and cool water fish in the United States would be reduced by about 50% according to certain climate models. The results for warm water fish are less certain.

Gitay et al. (eds.) "Climate Change and Biodiversity." Geneva: IPCC, 2002.

Available: <http://www.ipcc.ch/pub/tpbiodiv.pdf>

Description: A comprehensive study on ecosystem changes and responses of various species due to global warming. The authors predict increasing rates of species extinction and discuss possible mitigation techniques.

Glick, Patty. "Fish out of Water: A Guide to Global Warming and Pacific Northwest Rivers." Reston: National Wildlife Federation, 2005.

Available:

<http://www.nwf.org/nwfwebadmin/binaryVault/Fish%20Out%20of%20Water%2020051.pdf>

Description: The authors predict that 20% of the Pacific Northwest's rivers could become too warm for salmon, steelhead and trout by 2040. When water becomes too warm these fish experience slower growth rates and become more susceptible to disease. The 10 rivers in the region at greatest risk include the Columbia, Snohomish, Snoqualmie, Skykomish, Yakima, Snake, Deschutes, John Day, Klamath and Rogue rivers.

Inkley, D. B. et al. "Global climate change and wildlife in North America." Wildlife Society Technical Review 04-2. Bethesda: The Wildlife Society, 2004.

Available: http://iis-db.stanford.edu/pubs/20784/climate_change_technical_review.pdf

Description: The study discusses the impacts on wildlife due to habitat loss and changes. It presents case studies on amphibians, waterfowl, caribou and neotropical migrants. The authors note that the effects on wildlife in North America will vary widely according to species and location, but that many species will move north as the climate shifts. They stress the importance of wildlife managers adapting to changing conditions.

Kinsella, Steven. "The Impacts of Global Warming on Trout in the Interior West." New York: Natural Resources Defense Council, 2008.

Available: <http://www.nrdc.org/globalwarming/trout/trout.pdf>

Description: The report examines the impacts of climate change on trout habitat throughout the interior west and the economic implications of a widespread decline in trout populations. Trout habitat in the Interior West could be reduced by 50% or more by the end of the century. The authors argue for reductions in greenhouse gas emissions and examine management of the Blackfoot River as a model of conservation.

Nelitz, M et al. "Helping Pacific Salmon Survive the Impact of Climate Change on Freshwater Habitats." Vancouver: Pacific Fisheries Resource Conservation Council, 2007.

Available: <http://www.fish.bc.ca/files/PFRCC-ClimateChange-Adaptation.pdf>

Description: This study discusses the challenges Pacific salmon will face from climate change. It presents a number of strategies that will help salmon adapt to future changes. While the report focuses on Canada, the adaptation strategies could be useful in the U.S. as well.

O'Neal, Kirkman. "Effects of Global Warming on Trout and Salmon in U.S. Streams." Washington, DC: Defenders of Wildlife, 2002.

Available:

http://www.defenders.org/resources/publications/programs_and_policy/science_and_economics/global_warming/effects_of_global_warming_on_trout_and_salmon.pdf

Description: This study details the results of a simulation of the effects of climate change on four species of trout and four species of salmon. They find that there could be habitat losses of up to 38% for all 8 species by 2090. Loss of habitat for trout would be most pronounced in the South, Southwest and Northeast while the most salmon habitat would be lost in California. Losses could be higher when other pressures besides climate change are included.

Parmesan, Camille. "Ecological and Evolutionary Responses to Recent Climate Change." *The Annual Review of Ecology, Evolution, and Systematics*. 37 (2006): 637-69.

Available: http://cns.utexas.edu/communications/File/AnnRev_CCimpacts2006.pdf

Description: This study examines hundreds of papers on changes in species over time that can be attributed to climate change. The author finds significant changes in the distribution of plants and animals, most of which are biased in the directions predicted by climate change. Range-restricted species have seen their range severely restricted and have been most vulnerable to extinction.

Root, Terry et al. "'Fingerprints' of Global Warming on Wild Animals and Plants." *Nature* 421.6918 (2003): 57-59.

Available: <http://www.bo.cnr.it/www-sciresp/OLD/bacheca/pdf00003.pdf>

Description: A review of 143 studies on global warming and species ranging from mammals to grasses. The authors find strong evidence of temperature-related shifts in many species. Habitat destruction compounds this problem.

Root, Terry et al. "Human Modified Temperatures Induce Species Changes: Joint Attribution." *Proceedings of the National Academy of Sciences* 102.21 (2005): 7465-7469.

Available: <http://www.pnas.org/cgi/reprint/102/21/7465>

Description: The authors demonstrate a statistically significant two-step linkage that proves that human activities are altering global temperatures and that these temperatures are causing changes in plant and animal traits.

Root, Terry and Stephen Schneider. "Climate Change: Overview and Implications for Wildlife." In Schneider, SH and TL Root (eds), 2002: *Wildlife Responses to Climate Change: North American Case Studies*, Washington, DC: Island Press.

Available: [http://stephenschneider.stanford.edu/Publications/PDF_Papers/Overview\(1-56\).pdf](http://stephenschneider.stanford.edu/Publications/PDF_Papers/Overview(1-56).pdf)

Description: The article presents a brief history of climate change and climate projections. It includes a discussion of methodologies for studying plant and animal responses to climate change and presents examples of observed responses. It also includes some helpful tables.

Thomas, Chris et al., “Extinction Risk from Climate Change.” *Nature* Vol., 427.6970 (2004): 145-148.

Available:

http://www.fishclimate.ca/pdf/Extinction_risk_from_climate_change_Nature_2004.pdf

Description: The authors assess extinction risks for regions covering 20% of Earth’s terrestrial surface. They predict that 15-37% of species in the sample will be ‘committed to extinction’ by 2050.

Walther, Burga and Edwards (eds.). “Fingerprints of Climate Change: Adapted Behavior and Shifting Species Ranges.” New York: Plenum Publishers, 2001.

Available (partial):

<http://books.google.com/books?vid=ISBN030646716X&id=NY4ScCRkrvoC&pg=PA52&lpg=P A52&ots=9SC0vIypBl&dq=the+global+status+report:+bird+species+and+climate+change&sig=8YdfsdfUkpdXvluyVgsjdZi6PvM#PPP1,M1>

Description: A comprehensive book presenting case studies on various plants and animals, mostly in Europe.

Wormworth, Janice and Karl Mallon. “The Global Status Report: Bird Species and Climate Change.” Sydney: Climate Risk, 2006.

Available: <http://assets.panda.org/downloads/birdandclimatechangereport.pdf>

Description: A synthesis of scientific work on the impacts of climate change on birds, both now and in the future. The threats to birds from global warming are compounded by other threats such as development and habitat destruction.

Zöckler, Christoph and Igor Lysenko. “Water Birds on Edge: First Circumpolar Assessment of Climate Change Impact on Arctic Breeding Water Birds.” World Conservation Press, 2000.

Available: http://www.unep-wcmc.org/climate/waterbirds/WaterBirds_part1.pdf

Description: The study investigates the potential impact of climate change on birds that breed in the Arctic. They find that many species will be affected by changes in vegetation in their breeding range.

Energy

Crutzen, P.J. et al. “N₂O Release from Agro-Biofuel Production Negates Global Warming Reduction by Replacing Fossil Fuels.” *Atmospheric Chemistry and Physics Discussions* 7 (2007): 11191-11205.

Available: <http://www.atmos-chem-phys-discuss.net/7/11191/2007/acpd-7-11191-2007.pdf>

Description: The authors find that the warming effect of commonly used biofuels such as rapeseed biodiesel and corn ethanol is greater than conventional fossil fuels due to N₂O emissions from nitrogen fertilizer used to grow the crops. Rapeseed biodiesel has a warming effect 1.0-1.7 times greater than fossil fuels and corn ethanol is 0.9-1.5 times higher.

Climate Change Science Program (CCSP). “Effects of Climate Change on Energy Production and Use in the United States.” A Report by the U.S. Climate Change Science Program and the subcommittee on Global change Research. Thomas J. Wilbanks et al. (eds.). Department of Energy, Office of Biological & Environmental Research, Washington, DC, 2007.

Available: <http://www.climate-science.gov/Library/sap/sap4-5/final-report/sap4-5-final-all.pdf>

Description: The general findings are as follows. Global warming is expected to increase energy requirements for cooling and reduce requirements for warming. Overall, electricity use is expected to rise. Warming will affect energy production if extreme weather events become more intense and if there is decreased water availability at hydropower and/or thermal power plants. Warmer temperatures could also decrease thermoelectric power generation efficiencies. Climate change could also impact popular opinion about energy production and use and indirectly affect policymaking.

Field, C.B. et al. "North America." *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry et al. Eds., Cambridge: Cambridge University Press, 2007. 617-652.

Available: <http://www.gtp89.dial.pipex.com/14.pdf>

Description: The authors examine changes in energy demand and supply in North America starting on page 634. Electricity demand in the summer is expected to increase as temperatures rise. Hydropower yields in most of the country are expected to decrease.

Franco, Guido and Matt Fagundes. "Potential Changes in Hydropower Production from Global Climate Change in California and the Western United States." Sacramento: California Energy Commission, 2005.

Available: <http://www.energy.ca.gov/2005publications/CEC-700-2005-010/CEC-700-2005-010.PDF>

Description: 9-30% of the electricity used in California comes from hydropower. This study delineates the existing hydropower infrastructure in California, the Pacific Northwest and the Colorado River Basin and reviews climate change studies to determine the potential impacts on hydropower production. They find that hydropower production could shift more to the winter months. Overall changes in production are more difficult given the range of potential shifts in precipitation. They also find that climate change is generally not factored into long term hydropower plans.

Roberts, Martha, Timothy Male and Theodore Toombs. "Potential Impacts of Biofuels Expansion on Natural Resources: A Case Study of the Ogallala Aquifer Region." New York: Environmental Defense, 2007.

Available:

http://www.environmentaldefense.org/documents/7011_Potential%20Impacts%20of%20Biofuels%20Expansion.pdf

Description: In the areas of highest Ogallala Aquifer depletion, new corn ethanol plants under construction or planned will increase ethanol capacity by 900%. This could greatly increase stress on the overtaxed groundwater system. Water demands from the new plants could reach 2.6 billion gallons per year and could swell to 59-120 billion gallons per year if there are local increases in irrigated corn agriculture. The authors make recommendations to reverse this trend.

Roy, Sujoy, Karen Summers, and Robert Goldstein. "Water Sustainability in the United States and Cooling Water Requirements for Power Generation." *Water Resources Update* 126 (2003): 94-99.

Available: <http://www.ucowr.siu.edu/updates/127/Roy%20and%20Summers.pdf>

Description: The authors examine long-term water sustainability on a county level throughout the entire U.S. They focus particularly on water and energy use forecasts as compared to available precipitation forecasts to determine where water might be a constraining factor for energy production. The southwest is particularly susceptible to water supply shortages. The cooling water supply for thermoelectric power generation is expected to be limited throughout the southwest, northwest and southeast.

Scott, Michael et al. "Human Settlements, Energy, and Industry." *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. IPCC. Cambridge: Cambridge University Press, 2001.

Available: http://www.grida.no/climate/ipcc_tar/wg2/pdf/wg2TARchap7.pdf

Description: This chapter includes a section on the impacts on energy supply and demand beginning on page 399 (page 19 of the pdf). The authors predict the greatest change for hydroelectric power, finding that the change in peak flows may create unsafe conditions at dams. They predict an overall decrease in the amount of hydro power generated. There will be uncertain effects on other forms of renewable energy. Changes in energy use will depend on the region. It includes citations of many other relevant reports.

United States. Department of Energy. "Energy Demands on Water Resources: Report to Congress on the Interdependency of Energy and Water." Washington, October, 2006.

Available: <http://www.netl.doe.gov/technologies/coalpower/ewr/pubs/DOE%20energy-water%20nexus%20Report%20to%20Congress%201206.pdf>

Description: This report outlines the interconnections between water resources and energy production. It describes how water is used in and impacted by energy production. It also lays out the role of energy in pumping, transporting and treating water. Pressure on water resources will grow in the near future, both through increases in direct consumption and indirectly through increased demand for energy as population grows. Changes in cooling technologies at thermoelectric power plants could greatly reduce water withdrawals, but could significantly increase water consumption. The authors argue for integrated water and energy planning rather than considering the two resources separately.

U.S. Climate Change Science Program. "Effects of Climate Change on Energy Production and Use in the United States." A Report by the U.S. Climate Change Science Program and the subcommittee on Global Change Research. Thomas Wilbanks et al. (eds.). Department of Energy, Office of Biological & Environmental Research, Washington, DC, USA: 2007.

Available: <http://www.climatechange.gov/Library/sap/sap4-5/final-report/sap4-5-final-all.pdf>

Description: A peer reviewed draft of the section that will appear in the 2007 IPCC report as part of the Working Group II report. There will be an increase in electricity use due to greater home cooling needs, but also a decrease in energy for home heating. Effects on energy production will be modest except for regions that depend heavily on hydropower and experience large reductions in water availability.

Zah et al. "Life Cycle Assessment of Energy Products: Environmental Impact Assessment of Biofuels." St. Gallen, Switzerland, 2007.

Available:

http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=en&name=en_667574407.pdf

Description: The authors assess the greenhouse gas emissions and overall environmental impact of the entire production chain of various biofuels. Nearly all of the biofuels studied have lower greenhouse gas emissions than gasoline. However, due to negative environmental impacts ranging from rainforest clear-cutting to excessive fertilizer use, nearly half of the biofuels studied have an overall higher environmental impact than traditional fossil fuels. U.S. corn ethanol, Brazilian sugarcane ethanol and soy diesel all have higher environmental costs than fossil fuels. The most environmentally friendly biofuels included recycled cooking oil and ethanol made from grass or wood.

Reservoir-Greenhouse Gas Production

McCully, Patrick. "Flooding the Land, Warming the Earth." Berkeley: International Rivers Network, 2002.

Available: <http://www.irn.org/wcd/IRNGHGsgfromDams.pdf>

Description: The authors make the case that reservoir emissions contribute to climate change, drawing on recent research. They argue that reservoirs should be included in international climate change debates in the future.

McCully, Patrick. "Fizzy Science: Loosening the Hydro Industry's Grip on Reservoir Greenhouse Gas Emissions Research." Berkeley: International Rivers Network, 2006.

Available: <http://www.irn.org/pdf/greenhouse/FizzyScience2006.pdf>

Description: The article describes the growing controversy around reservoir emissions and the need for an IPCC special report on the topic in order to secure an unbiased assessment. It also reviews the state of the current evidence. The authors conclude that there is strong evidence supporting significant emissions from reservoirs.

Rosa, Luiz and Marco dos Santos. "Certainty and Uncertainty in the Science of Greenhouse Gas Emissions from Hydroelectric Reservoirs." Cape Town: World Commission on Dams, 2000.

Available: http://www.wcainfonet.org/servlet/BinaryDownloaderServlet?filename=1066749380695_certainty.pdf&refID=115565

Description: The authors examine the contribution of hydro reservoirs to climate change and how the emissions should be measured. They develop a model for comparing emissions from hydro reservoirs with emissions from thermal power plants. They find that methane production from reservoirs can be a significant contributor to climate change. They reject traditional assumptions that there are no GHG emissions from hydro projects and argue that emissions from reservoirs should be considered in planning future hydro projects.

St Louis, Vincent et al. "Reservoir Surfaces as Sources of Greenhouse Gases to the Atmosphere: A Global Estimate." *BioScience* Vol. 50.9 (2000): 766-775.

Available: http://www.biology.ualberta.ca/faculty/vincent_stlouis/uploads/pdfs/BioScience%20paper.pdf

Description: The authors determine the global contribution of reservoirs to climate change. Reservoirs eliminate carbon sinks and cause bacteria to decompose organic carbon stored in

plants and soils, releasing CO₂ and methane. They estimate that emissions from reservoirs could account for 7% of the global warming potential of other documented anthropogenic emissions. Different landscapes emit different levels of the gasses. Tropical ecosystems generally emit higher levels of greenhouse gases.

World Commission on Dams. “Dams and Development: A New Framework for Decision-Making.” London: Earthscan Publications, 2000.

Available: <http://www.damsreport.org/docs/report/wcdreport.pdf>

Description: The WCD maintains that dams are a benefit to humankind, but note that there the traditional cost-benefit calculus used to make decisions about dams has been incomplete. They propose a new paradigm. The report includes a brief discussion of GHG emissions on page 75 (110 of pdf).

World Commission on Dams Secretariat. “Final Minutes from the Workshop on Dam Reservoirs and Greenhouse Gases.” Montreal: World Commission on Dams, 2000.

Description: The minutes from a conference focusing on areas of disagreement among leading scientists on emissions from reservoirs. Participants agreed on a number of points, including that there are emissions from reservoirs and that fully understanding changes in emissions is a very complex process requiring further study.

Recreation

Field, C.B. et al. “North America.” *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry et al. Eds., Cambridge: Cambridge University Press, 2007. 617-652.

Available: <http://www.gtp89.dial.pipex.com/14.pdf>

Description: This chapter discusses impacts on recreation in North America. Changes in the length of operating season will be one key factor in how tourism is impacted. A greater number of warm days may benefit northern tourism destinations. Winter recreation such as skiing will likely be negatively affected, although not as much as previously thought due to advances in snow making. In coastal areas, adaptation strategies to counter rising sea levels will become increasingly costly.

Hall, Michael and James Higham (eds). “Tourism, Recreation, and Climate Change.” Clevedon: Channel View Publications, 2005.

Description: This book presents case studies of the impacts of global warming on tourism and recreation around the world, including a chapter on North America.

Hamilton, Jacqueline, David Maddison, and Richard Tol. “Climate Change and International Tourism: A Simulation Study.” *Global Environmental Change* Vol. 15 (2005): 253-266.

Available: <http://www.uni-hamburg.de/Wiss/FB/15/Sustainability/gectourism.pdf>

Description: The authors simulate tourism patterns in a changing climate. They find that international tourism will grow in the medium to long term in spite of climate change.

Hamilton, Jacqueline and Richard Tol. “The Impact of Climate Change on Tourism and Recreation.” Working Paper.

Available: <http://www.uni-hamburg.de/Wiss/FB/15/Sustainability/tourlitrev.pdf>

Description: A literature review of the emerging body of work on tourism, recreation and climate change.

Wall, Geoffrey. “Implications of Global Climate Change for Tourism and Recreation in Wetland Areas.” *Climactic Change* Vol. 40.2 (1998): 371-389.

Abstract: <http://www.springerlink.com/content/n01r097418x83x24/>

Description: Wetland recreation in coastal areas will be affected by rising sea levels while recreation in inland water bodies will be negatively impacted by decreases in water levels.

Agriculture

Adams, Richard, Brian Hurd and John Reilly. “A Review of Impacts to U.S. Agricultural Resources.” Arlington: Pew Center on Global Climate Change, 1999.

Available: <http://www.pewclimate.org/docUploads/env%5Fagriculture%2Epdf>

Description: The report analyzes existing research on climate change and agriculture in the U.S. Crop yields in the Northern U.S. and Canada may increase, while they likely will decrease in warmer southern regions. Yields will grow under moderate temperature increases while they will drop if temperatures rise beyond about 7.2 degrees Fahrenheit. Extreme weather events will also have large impacts.

Bazzaz, Fakhri and Wim Sombroek. “Global Climate Change and Agricultural Production: Direct and Indirect Effects of Changing Hydrological, Pedological and Plant Physiological Processes” Rome: FAO, 1996.

Available: <http://www.fao.org/docrep/W5183E/W5183E00.htm>

Description: A very detailed and lengthy scientific document on projected changes in agricultural production. It includes sections on changes to the hydrological cycle, soil conditions, CO₂ fertilization, radiation levels, food security and other topics.

FAO. “Special Event on Impact of Climate Change, Pests and Diseases on Food Security and Poverty Reduction.” 31st Session of the Committee on World Food Security, 2005.

Available: <http://www.fao.org/clim/docs/CFS/CFS.pdf>

Description: Climate change and its attendant changes in pest and disease patterns will have a direct impact on food security and poverty levels. The rural poor in developing countries will have a difficult time adapting to these changes and will be unable to afford the higher prices that will result.

Fischer, Günther, Mahendra Shah and Harrij van Velthuisen. “Climate Change and Agricultural Vulnerability.” Laxenburg: International Institute for Applied Systems Analysis, 2002.

Available: <http://www.iiasa.ac.at/Research/LUC/IB-Report.pdf>

Description: The first comprehensive ecological-economic assessment of the impact of climate change on agro-ecosystems in the context of the world food and agricultural system. It examines possible changes in food production, trade and consumption and the effects on poverty and hunger.

Mendelsohn, Robert and Ariel Dinar. “Climate Change, Agriculture and Developing Countries: Does Adaptation Matter?” *The World Bank Research Observer* Vol. 14.2 (1999): 277-293.

Available: <http://www.worldbank.org/research/journals/wbro/obsaug99/article6.pdf>

Description: Global warming will threaten the welfare and economic development of developing countries dependent on agriculture. This study argues that adaptation by farmers will mitigate these negative impacts.

Reilly, J., et al. “Agriculture: The Potential Consequences of Climate Variability and Change for the United States.” US National Assessment of the Potential Consequences of Climate Variability and Change, US Global Change Research Program. New York: Cambridge University Press, 2001.

Available: <http://www.usgcrp.gov/usgcrp/Library/nationalassessment/Agriculture.pdf>

Description:

Climate change will not imperil agricultural production in the US during the 21st century. Productivity of many major crops will increase on the national levels while others will increase or decrease on a regional basis. Productivity will like increase greatly in the Midwest, West and Pacific Northwest and decrease in the South and Plains States. Water needs for irrigated agriculture decreased in the short and medium term.

Schimmelpfennig, David et al. “Agricultural Adaptation to Climate Change: Issues of Long-run Sustainability.” USDA Agricultural Economic Report No. AER740, 1996.

Available: <http://www.ers.usda.gov/publications/aer740/>

Description: A thoroughly documented summary of research on the impacts of climate change on agriculture.

Strategies for Adaptation and Mitigation

Ackerman, Frank and Elizabeth Stanton. “The Cost of Climate Change: What We’ll Pay if Global Warming Continues Unchecked.” Natural Resources Defense Council, 2008.

Available: <http://www.nrdc.org/globalwarming/cost/cost.pdf>

Description: The report finds damages from global warming in the U.S. could reach 3.6% of gross domestic product (GDP) by 2100 under a business-as-usual emissions scenario. They focus primarily on the costs of hurricane damage, real estate losses, energy costs and water costs. In order to avoid these impacts, the authors recommend aggressively reducing emissions, encouraging investment in energy efficiency and accelerating the deployment of clean energy technologies.

Banuri et al. “Climate Change 2001: Mitigation.” IPCC Working Group III. Cambridge: Cambridge University Press, 2001.

Available: http://www.grida.no/climate/ipcc_tar/wg3/index.htm

Description: A comprehensive report that assesses the scientific, technical, environmental, economic and social aspects of climate change mitigation.

Burton, Ian, Elliot Diringer and Joel Smith. *Adaptation to Climate Change: International Policy Options.* Pew Center on Global Climate Change, 2006.

Available: <http://www.pewclimate.org/docUploads/PEW%5FAdaptation%2Epdf>

Description: This report stresses the importance of adaptation to changes brought about by global warming rather than focusing solely on mitigation. The authors explore international adaptation efforts to date and in the future.

California Department of Water Resources. “Managing an Uncertain Future: Climate Change Adaptation Strategies for California’s Water.” Sacramento: Department of Water Resources, 2008.

Available: <http://www.water.ca.gov/climatechange/docs/ClimateChangeWhitePaper.pdf>

Description: The authors argue that California faces a growing water crisis due to climate change and present 10 adaptation strategies to cope with future challenges. The strategies include increased funding for water management, investing in water efficiency, practicing integrated flood management, protecting vital ecosystem and increasing the research and monitoring.

Center for Science in the Earth System, Joint Institution for the Study of the Atmosphere and Ocean, University of Washington and King County Washington. “Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments.” 2007.

Available: <http://www.cses.washington.edu/db/pdf/snoveretalgb574.pdf>

Description: The guidebook lays out a process for governments to adapt to the particular effects climate change will have on their communities. It describes how to gauge the impacts of climate change, build a climate preparedness team, assess vulnerability and risk, set preparedness goals, identify implementation tools and measure resilience. It also includes a primer on climate change impacts and additional resources on impacts and preparedness.

Costanza, Robert et al. “The Value of Coastal Wetlands for Hurricane Protection.” *Ambio* 37.4 (2008): 241-248.

Description: The authors find that protection and restoration of coastal wetlands is an extremely cost effective strategy for reducing damages from hurricanes. They find that the loss of one hectare of wetlands corresponds to an average increase of \$33,000 in storm damages. They estimate that coastal wetlands provide \$23.2 billion in annual storm protection services in addition to other ecosystem services. The authors note that this value will increase if climate change leads to more frequent and more intense storms.

Cruce, Terri. “Adaptation Planning: What U.S. States and Localities are Doing.” Pew Center on Global Climate Change. 2009.

Available: <http://www.pewclimate.org/working-papers/adaptation>

Description: This paper focuses on adaptation planning efforts by both state and local governments. Many of these efforts are in their earliest stages. Some states are including adaptation within the scope of their state Climate Action Plans addressing GHG emissions. A few others have recognized the need for separate and comprehensive adaptation commissions to parallel their mitigation efforts. Many are simply responding to climate impacts as they occur, without necessarily attributing the impacts to climate change.

Easterling, William, Brian Hurd and Joel Smith. “Coping with Global Climate Change: The Role of Adaptation in the U.S.” Pew Center on Global Climate Change, 2004.

Available: <http://www.pewclimate.org/docUploads/Adaptation%2Epdf>

Description: The authors stress adaptation as an essential complement to mitigation. The cost of adaptation measures will depend to a large degree on how much and how rapidly the climate shifts. Proactive adaptation can reduce vulnerability to climate change.

The Economics of Climate Adaptation Working Group. “Shaping Climate-Resilient Development: A Framework for Decision-Making.” 2009.

Available: http://www.rockfound.org/initiatives/climate/shaping_climate%20res_dev.pdf

Description: This report creates a framework that decision-makers can use to assess the vulnerability of their economy to climate change and explore adaptation measures to minimize losses. They include results from testing the framework in eight countries including the U.S. They find that while significant economic value is at risk in a changing climate, a portfolio of cost-effective measures can greatly reduce vulnerability. 40-100% of expected losses by 2030 can be averted through effective adaptation efforts, even under high climate change scenarios.

Ehrhardt-Martinez, Karen and John Laitner. “The Size of the U.S. Energy Efficiency Market: Generating a More Complete Picture.” Washington, DC: American Council for an Energy-Efficient Economy, 2008.

Available: <http://www.aceee.org/pubs/e083.htm>

Description: The study finds that the U.S. can reduce energy consumption by 25-30% or more over the next 20-25 years. The authors recommend a set of policies that will increase investment in efficient technologies and promote and reward adoption of such technologies.

Franco, Guido. “Climate Change Impacts and Adaptation in California.” Sacramento: California Energy Commission, 2005.

Available: <http://www.energy.ca.gov/2005publications/CEC-500-2005-103/CEC-500-2005-103.PDF>

Description: The study presents a review of the literature on climate change impacts and adaptation options for California. They note that climate change will exacerbate existing pressures on ecosystems in the state and negate the benefits of current conservation programs. Adaptation measures include increasing water efficiency, limiting development in vulnerable areas, creating nature reserves and increasing permeable pavement use.

Government Accountability Office (GAO). “Climate Change Adaptation: Strategic Federal Planning Could Help Government Officials Make More Informed Decisions.” Washington, DC: 2009.

Available: <http://www.gao.gov/products/GAO-10-113>

Description: This report examines a number of ongoing adaptation efforts on the local, state and federal level, finding that most institutions are not adequately preparing for climate risks. Through a survey of decision-makers, the report explores barriers to more effective adaptation and suggests steps the federal government can take to facilitate these efforts.

The H. John Heinz III Center for Science, Economics and the Environment. “A Survey of Climate Change Adaptation Planning.” Washington, DC, 2007.

Available:

http://www.heinzcenter.org/publications/PDF/Adaptation_Report_October_10_2007.pdf

Description: This study provides an overview of the resources available to help with urban adaptation planning, examining eight guidebooks and frameworks from the U.S. and other Western, developed countries. It also reviews a number of adaptation planning efforts currently underway, including 11 in the U.S.

Kabat, Pavel, Henk van Schaik, et al. “Climate changes the water rules: How water managers can cope with today's climate variability and tomorrow's climate change.” The Netherlands: Dialogue on Water and Climate, 2003.

Available: <http://www.waterandclimate.org/report.htm>

Description: The study uses examples of extreme weather to demonstrate climate shifts and highlight the need for water managers to factor climate change into long-term calculations. The report presents the evidence for climate change, details the impacts, assesses vulnerability, lists adaptation strategies and makes recommendations for countries and water managers.

Robert J. Lempert, Steven W. Popper, Steven C. Bankes. “Shaping the Next One Hundred Years: New Methods for Quantitative, Long-Term Policy Analysis

Available: http://www.rand.org/pubs/monograph_reports/MR1626/

Description: Today’s choices will significantly influence the course of the twenty-first century. New analytic methods, enabled by modern computers, may transform our ability to reason systematically about the long term. This report reviews traditional methods of grappling with the morrow, from narratives to scenario analysis, which fail to address the multiplicity of plausible long-term futures. The authors demonstrate a quantitative approach to long-term policy analysis (LTPA). Robust decision methods enable decisionmakers to examine a vast range of plausible futures and design near-term, often adaptive, strategies to be robust across them.

Luers, Amy Lynd and Susanne Moser. “Preparing for the Impacts of Climate Change in California: Opportunities and Constraints for Adaptation.” White Paper CEC-500-2005-198-SF. Berkeley: California Climate Change Center, 2005.

Available: <http://www.energy.ca.gov/2005publications/CEC-500-2005-198/CEC-500-2005-198-SF.PDF>.

Description: This report examines California’s opportunities and constraints for managing the impacts of climate change. Among the key findings are the following: 1. It is not a choice between mitigation and adaptation. The state must determine a portfolio of solutions that will best minimize potential risks and maximize potential benefits. 2. Adaptation is being addressed by the international community and ignored by the U.S. 3. California has a significant ability to adapt, but implementing real adaptive actions is difficult.

Mantua, Nathan et al. “A Description and Evaluation of Hydrologic and Climate Forecast and Data Products that Support Decision-Making for Water Resources Managers.” *Decision Support Experiments and Evaluations Using Seasonal to Interannual Forecasts and Observational Data: A Focus on Water Resources*. Washington, DC: U.S. Climate Change Science Program, 2008.

Available: <http://www.climate-science.gov/Library/sap/sap5-3/final-report/default.htm>

Description: This chapter argues that there is a wide variety of climate and hydrologic forecasting available for use by water resources managers, but little of it is used. The chapter includes a discussion of the information sources available and their shortcomings.

Miles, Edward et al. "Pacific Northwest Regional Assessment: The Impacts of Climate Variability and Climate Change on the Water Resources of the Columbia River Basin." *Journal of the American Water Resources Association* Vol. 36.2 (2000): 399-420.

Abstract: <http://www.awra.org/jawra/papers/J99074.html>

Description: An assessment of climate change impacts for the PNW. The authors find that the Columbia River Basin is susceptible to climate change, especially drought. They also find that management inertia and the lack of a centralized authority coordinating all uses of the resource impede adaptability to drought and optimization of water distribution. Climate change projections suggest exacerbated conditions of conflict between users as a result of low summertime streamflow conditions.

Moser, Susanne. "Good Morning, America! The Explosive U.S. Awakening to the Need for Adaptation." 2009.

Available: <http://www.csc.noaa.gov/publications/need-for-adaptation.pdf>

Description: This report provides a historical overview of adaptation in the U.S. and identifies barriers to more effective adaptation efforts on the local, state and federal level. The report finds that the U.S. does not currently have the capacity, resource base, institutional mechanisms or political will for effective adaptation. It concludes with recommendations for improving the nation's adaptation capacity.

Nelson, Barry et al. "In Hot Water: Water Management Strategies to Weather the Effects of Global Warming." Natural Resources Defense Council and Water Policy Program, 2007.

Available: <http://www.nrdc.org/globalWarming/hotwater/contents.asp>

Description: This report examines the impacts of climate change on water supply, flood control and aquatic ecosystems in the West. The authors propose a set of recommendations for water managers to use in adapting to these impacts.

Purkey, D.; Huber-Lee, A.; Yates, D.; Hanemann, M.; Herrod-Julius, S. "Integrating a climate change assessment tool into stakeholder-driven water management decision-making processes in California". 2007. *Water Resources Management* 21: 315-329

Scientific Expert Group on Climate Change (SEG). "Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable." Report Prepared for the United Nations Commission on Sustainable Development. Sigma Xi, Research Triangle Park, NC, and the United Nations Foundation, Washington, DC, 2007.

Available: <http://www.unfoundation.org/SEG/>.

Description: A report focusing on the necessity of mitigation and adaptation in the fight against climate change. The authors believe that any increase in temperature over 2-2.5 degrees above 1750 levels will cross a tipping point that could lead to intolerable and catastrophic impacts. To prevent this, the world must halt growth in CO₂ emissions by 2015-2020 and reduce them to a third of that level by 2100. The authors lay out a roadmap combining mitigation and adaptation to avoid the worst of the impacts of climate change.

Seavy, Nathaniel et al. "Why Climate Change Makes Riparian Restoration More Important than Ever: Recommendations for Practice and Research." *Ecological Restoration* Vol. 27.3 (2009): 330-338.

Available: <http://er.uwpress.org/cgi/reprint/27/3/330>

Description: This study examines how riparian restoration can prepare ecological systems for the impacts of climate change. The authors argue that riparian ecosystems are naturally resilient, provide habitat connectivity, link aquatic and terrestrial ecosystems and create thermal refugia for wildlife. They provide suggestions for adapting restoration projects to enhance resilience.

Smit, Barry et al. “Adaptation to Climate Change in the Context of Sustainable Development and Equity.” *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. IPCC. Cambridge: Cambridge University Press, 2001.

Available: http://www.grida.no/climate/ipcc_tar/wg2/pdf/wg2TARchap18.pdf

Description: This chapter evaluates potential adaptation strategies and discusses adaptive capacity of various communities. Adaptation has the potential to greatly reduce the negative impacts and enhance the beneficial impacts of climate change. Adaptive capacity is determined by socioeconomic characteristics of communities.

Tanaka, Stacy et al. “Climate Warming and Water Management Adaptation for California.” *Climatic Change* Vol. 76.3-4 (2006): 361-387.

Available: <http://cee.engr.ucdavis.edu/faculty/lund/papers/ClimateChangeCALVIN2005.pdf>

Description: A review of the ability of California’s water supply to adapt to climatic and demographic shifts. They find that California can adapt through large changes in the operation of groundwater storage capacity, significant water transfers and adoption of new technologies. These changes will likely be very costly.

Van Vuuren, D.P. et al. “Temperature Increase of 21st Century Mitigation Scenarios.” *Proceedings of the National Academy of Sciences* 105.40 (2008): 15258-15262.

Description: This study examines potential warming scenarios based on various levels of emissions reductions. They find a range of 0.5-4.4°C over 1990 levels. Even in the most stringent emission reduction scenarios, there was an average warming of 1.4°C, significantly higher than previous estimates. The authors conclude that adaptation measures will be needed as a result.

Webster, Mort et al. “Analysis of Climate Policy Targets under Uncertainty.” Joint Program on the Science and Policy of global Change, Massachusetts Institute of Technology, 2009.

Available: http://globalchange.mit.edu/files/document/MITJPSPGC_Rpt180.pdf

Description: This study finds that efforts to reduce greenhouse gas emissions have a 50/50 chance to keep the increase in global average temperatures to around 2°C if they are undertaken soon. If action is not taken soon, however, extreme changes may be difficult or impossible to avoid.

Young, C.A.; Escobar-Arias, M.I.; Fernandes, M.; Joyce, B.; Kiparsky, M.; Mount, J.F.; Meta, V.K. Purkey, D.; Viers, J.H.; Yates, D. 2009, “Modeling the hydrology of climate change in California’s Sierra Nevada for subwatershed scale adaptation”, *Journal of the American Water Resource Association*, 45 (6): 1409-1423.

Available: <http://sei-international.org/?p=publications&task=view&pid=1414>

Description: The rainfall-runoff model presented in this study represents the hydrology of 15 major watersheds of the Sierra Nevada in California as the backbone of a planning tool for water resources analysis including climate change studies.